REINFORCED POLYMER SHOCK ABSORBING PAD

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of U.S. Patent Application Serial No. _______________, filed September 26, 2003, which is a continuation-in-part U.S. Patent Application Serial No. 10/613,740, filed July 3, 2003, which is a continuation-in-part of U.S. Patent Application Serial No. 10/094,030, filed March 7, 2002, the contents of which are hereby incorporated in their entirety.

FIELD OF THE INVENTION

This invention generally relates to polymeric pads and in greater detail the invention relates to a viscoelastic, shock-attenuating elastomeric pad comprising a reinforcing material.

BACKGROUND OF THE INVENTION

Enhanced participation in contact sports, such as football, soccer, and rugby, along with enhanced participation in other high impact energy activities, such as inline skating and white water kayaking, has fueled the demand and need for improved impact absorbing materials. These types of contact sports and high-impact activities often cause application of high energy impacts against discrete portions of the human body that often cause bruises and even more serious injuries, such as broken or fractured bones.

Besides the noted contact sports and high energy impact activities, there are a number of other activities that, in the event of an accident or spill, may cause injury to the body. Until the past few years, participation in these activities, such as bicycle riding, was not considered to be an activity requiring much protective equipment. Now, however, bicycle riders of all ages are routinely advised to wear a protective bicycle helmet. Also, over the past few years, there has been a tremendous growth in off-road activities, such as mountain biking, motocross on both bicycles and motorcycles, and all terrain vehicle (ATV) usage on off-road trails.

There has been a tremendous rate of growth in other applications for impact absorbing materials. Even in more mundane activities, such as walking, there has been an increased emphasis upon energy-absorbing surfaces and products for human beings. Manufacturers are increasingly marketing energy absorbing soles for shoe purchasers. Indeed, there is a large market demand for after market impact absorbing shoe inserts. Marketing of such shoe inserts is often targeted to participants in sports such as basketball, football, soccer, and running, where repetitive impact during each successive step may cause injuries to the foot and lower leg, such as sprains, shin splints, and even broken bones.

Due to the enhanced market for impact absorbing materials, great strides have been made toward reducing injuries generated by impacts that are applied against the human body. However, many of these new impact absorbing materials merely amount to laminates of multiple layers. Typically, such layers suffer from a couple of different problems. For example, a layer will often inhibit the ability of adjacent layers to fully exhibit the properties, such as elasticity, of the adjacent layers. For

example, where a pair of layers are laminated together, and both layers have a certain degree of elasticity, the layer with the lower degree of elasticity will inhibit the layer with the higher degree of elasticity from fully exhibiting that higher degree of elasticity. Also, where one layer is fairly rigid and an adjacent continuous layer is fairly flexible, the fairly rigid layer will inhibit the ability of the flexible continuous layer to exhibit the flexibility.

The existing impact absorbing materials that are formed of layers necessarily must sacrifice some degree of impact absorbing capability. First, layer thickness is typically minimized to prevent the impact absorbing material from becoming too heavy and bulky for consumer tastes. Also, to the degree that impact absorbance depends upon elevated rigidity in one of the layers, existing impact absorbing materials consequently sacrifice flexibility and the ability to conform to complex three-dimensional shapes in favor of enhanced impact absorbance capability, or, alternatively, sacrifice impact absorbing capability in favor of enhanced flexibility and ability to conform to complex three-dimensional surfaces.

As another example, impact absorbing products have been developed that incorporate a fluid within a polymeric envelope. When an impact is applied against one portion of the envelope, the fluid is displaced to a portion of the envelope located away from the impact point on the envelope. The envelope is typically made of a somewhat flexible polymeric material. The energy of the impact against the envelope is typically dissipated by generation of pressure in the fluid, with the consequential expansion of the envelope. While such an impact absorbing material does, theoretically, have many benefits, practical considerations limit the actyual

capabilities of such a material. For example, the volume of fluid within the envelope must typically be limited due to the density of the fluid contained within the envelope and the consequent overall weight of the fluid-filled envelope. Such limitations of the envelope volume necessarily limit the thickness of the fluid layer within the envelope, which thereby detracts from the impact absorbing capabilities of the fluid-filled envelope.

Thus, a need exists for an impact absorbing material that exhibits both enhanced flexibility and conformability along with enhanced impact absorbing capabilities. Furthermore, what is needed is an impact resistant material this is both light weight and flexible.

SUMMARY OF THE INVENTION

The present invention generally relates to a reinforced polymeric pad for absorbing energy comprising a polymeric gel and a substrate contained within an envelope. The pad exhibits low rebound velocity and high hysteresis, among other desirable characteristics which are conducive to the function of a good energy-attenuating material. The polymeric pad is capable of repeatedly absorbing shock without structural damage and without appreciable sag due to prolonged exposure to continuous dynamic loading.

Generally the reinforced polymeric pad comprises a polymeric gel and substrate enveloped by a top and bottom layer. The substrate has a density less than that of the polymeric gel. The substrate may be formed from a foamed plastic and may be a continuous sheet or have perforations placed throughout. The polymeric gel

can be formed from an epoxidized vegetable oil, a thermoplastic polymer and a prepolymer. The epoxidized vegetable oil generally encompasses either an epoxidized soybean or linseed oil, or combinations of the two. The top and bottom layer can be formed from a non-woven resilient material.

In an additional embodiment, the reinforced polymeric pad comprises a gel formed from an epoxidized vegetable oil and a thermoplastic polymer which is substantially free of a polyurethane, and a substrate formed from a foamed plastic. The foamed plastic has a density less than that of the polymeric gel. The pad comprises an envelope formed from two opposed layers joined at the periphery. The gel and substrate are contained within the envelope, and in one embodiment, the gel surrounds the substrate.

A further embodiment includes a method of forming a reinforced polymeric pad by joining two opposed layers to form an envelope containing within a polymeric gel and a substrate. The opposed layers may be fused together at the periphery using heat or may be mechanically joined. The layers are typically formed from a resilient non-woven material.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a side view of the present reinforced polymeric pad depicting the shock absorbing envelope comprising both the polymeric gel and the substrate; and

Fig. 2 depicts a further embodiment of the reinforced polymeric pad depicting the substrate having various perforations enveloped in an envelope comprising the polymeric gel.

DETAILED DESCRIPTION

In greater detail, the present invention comprises a reinforced polymeric pad including a shock absorbing envelope comprising a polymer gel and a substrate. The shock absorbing envelope is formed by the joining of two opposed layers 4, 6 joined at the periphery to comprise a compartment formed between the two layers 4, 6 wherein a substrate and polymeric gel are contained.

The layers 4, 6 defining the envelope are typically formed from a non-woven material such as a resilient polymeric polymer sheet and are capable of withstanding repeated impact. The two opposed layers 4, 6 defining the envelope in which the polymeric material and substrate 10 are contained, may be formed of most any material capable of providing impact resistance.

The substrate 10 typically has a density less than that of the polymeric gel 8 and decreases the overall weight of the pad 2 while adding some rigidity to it. The substrate 10 may be formed of most any material so long as it does not impede the impact resistance of the reinforced pad 2. For example, the substrate 10 may be formed from a foamed plastic such as a polyvinyl chloride, or the substrate 10 may be formed from a felt material.

The polymeric gel 8 component of the reinforced pad 2 may be comprised of most any elastomeric material. While the gel 8 component is described as a polymeric gel 8, the term "gel" is not meant to be restrictive and is only used to describe the component as having gel-like qualities. The use of the term "gel" is not intended to be restrictive as to describing only a colloidal system, but is used to

describe any semi-solid substance that is both resilient and elastic. Typically, the polymeric gel 8 is formed from an epoxidized vegetable oil combined with a prepolymer and a thermoplastic polymer. The gel 8 compound is capable of absorbing impact and energy and has a density greater than that of the substrate 10.

Opposed Layers

The opposed layers 4, 6 defining an envelope therebetween, can be fused together using heat if the layers 4, 6 are formed from a material conducive to such fusing. An example of a fusible material would be a vinyl sheet or other polymeric material that melts and fuses upon solidification. Additionally the layers 4, 6 may be joined using mechanical means such as stitching, stapling or other fasteners. Adhesives may also be used to join the layers 4, 6 together, or a combination of any of the methods mentioned above or those known in the art may be used for joining the layers 4, 6 .

The reinforced polymeric shock absorbing pad 2 may be comprised of one or more envelopes residing in a single pad 2. The two opposed layers 4, 6 may be joined at multiple points creating a plurality of envelopes encompassing the substrate 10 and gel compound.

The opposed layers 4, 6 may be formed from a sheet of a resilient polymeric material. Additionally, the opposed layers 4, 6 may be formed from a woven or a non-woven material capable of containing the gel 8 and substrate 10 and able to withstand rupturing upon impact. Furthermore, it is contemplated that the envelope may be comprised of more that two layers 4, 6 and that the envelope may be encased in a further envelope to add protection and durability to the pad 2.

Substrate

The substrate 10 functions essentially as a filler for providing both weight reduction in the pad 2 and rigidity. The substrate 10 may be formed from a foam polymer such as a PVC, or a nonwoven material such as a felt pad. Additionally, other materials are also known in the art, which have a density less than the gel 8 and can provide the same functions. The substrate 10 may formed from a continuous sheet of material or may have perforations as illustrated in Figure 2. Additionally, the substrate 10 may substantially span the entire envelope or just reside in a portion of the envelope. In one embodiment it is contemplated that the substrate 10 spans at least 50% or more of the area of the pad 2. In a further embodiment, the substrate 10 spans at least 75% of the pad 2.

The thickness of the substrate 10 is limited only be the desired ultimate thickness of the pad 2 and the desired overall weight in the pad 2. Furthermore, the substrate 10 may be a continuous sheet or be comprised of multiple sheets within the pad 2. It is further contemplated that the substrate 10 may be comprised of particles such as foamed beads of PVC, which are less dense that the polymeric gel 8.

Polymeric Gel

The energy absorbing polymeric compound may be comprised of most any polymeric gel. Typically, and in an embodiment, the gel 8 has a density greater than the substrate 10. The gel 8 incorporated into the envelope is both viscoelastic and shock-attenuating.

An example gel 8 compound is one that comprises an epoxidized vegetable oil combined with a prepolymer and a thermoplastic polymer. Additionally, a catalyst or an accelerant may be added to the energy absorbing compound to aid in the formation of the compound. Typically the activator or accelerant is a metal activator such as an alkyl tin compound.

The elastomeric compound includes an epoxidized vegetable oil which can function as a plasticizer. By way of example, the epoxidized vegetable oils can include epoxidized soybean oil, epoxidized linseed oil and epoxidized tall oil. Additional examples of epoxidized vegetable oils include epoxidized corn oil, epoxidized cottonseed oil, epoxidized perilla oil and epoxidized safflower oil. Epoxidized vegetable oils are typically obtained by the epoxidation of triglycerides of unsaturated fatty acid and are made by epoxidizing the reactive olefin groups of the naturally occurring triglyceride oils. Typically, the olefin groups are epoxidized using a peracid. One example of an acceptable epoxidized vegetable oil is an epoxidized soybean oil, Paraplex G-62, available from C.P. Hall Company of Chicago, Illinois. Paraplex G-62 can function as both a plasticizer and a processing aid and is a high molecular weight epoxidized soybean oil on a carrier having an auxiliary stabilizer for a vinyl group.

The elastomeric composition includes a prepolymer. Various prepolymers may be utilized in the present composition so long as they do not substantially hinder the desired viscoelastic, shock-attenuating attributes of the elastomeric compound. Typically, the prepolymer is an isocyanate.

The thermoplastic component can include most any thermoplastic compound having elastomeric properties. In one embodiment of the gel 8, thermoplastic compounds comprising polyurethane are excluded. Acceptable thermoplastic component includes polydienes. An example polydiene includes polybutadiene. Typically, the activator or catalyst is an alkyl tin compound is also added to the gel 8 compound. A specific example of an alkyl tin compound is a dioctyltin carboxylate.

It is within the scope of the present invention to incorporate other additives such as fillers, pigments, surfactants, plasticizers, organic blowing agents, as stabilizers, and the like, in the manufacture of the reinforced polymeric shock absorbing pad 2.

It will be understood by those skilled in the art that while the present invention has been discussed above with respect to various preferred embodiments and/or features thereof, numerous changes, modification, additions and deletions can be made thereto without departing from the spirit and scope of the invention as set forth in the following claims.